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DO ELEPHANTS EVER FORGET?[1]

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Three adult female elephants (*Elephas maximus*) were tested on a light-dark discrimination problem with an 8-yr intertrial interval. The first subject took only 6 min to reach criterion and made only two errors, suggesting remarkable retention. The other two subjects were found to have visual anomalies that would have gone undetected without this research.

DESCRIPTORS: elephants, memory, vision, visual discrimination, behavioral engineering in the zoo, long-term memory

In 1964, Squier reported initial results of testing female elephants (*Elephas maximus*) in the Portland Zoo. Included in the training was the successful completion of a light-dark simultaneous discrimination task. Ultimately, administrative policies within the zoo made it impossible to continue the research at that time. Some years later, refurbishing of the equipment, which was salvaged from a scrap heap, allowed testing of the effects of an intertrial interval in excess of 8 yr.

Although the earlier report (Squier, 1964) provided general information, the raw data were destroyed in a fire at Reed College in 1968. Thus, comparisons must be made with the recognition that all subjects were previously trained to the same criterion described in this article, but without fine-grain information concerning the number of trials in the original testing.

METHOD

Subjects

Three adult female Indian Elephants (*Elephas maximus*), Rosy, born 1949 in Thailand; Tuy Hoa, born 1955 in Saigon, and Belle, born 1952 in Thailand, served.

Apparatus

Constructed of plywood, with a slate operant panel, the test apparatus measured 2.08 m high by 1.24 m deep by 0.86 m wide. The response panel, set at a 25° angle on the front, was 0.79 m wide by 0.91 m high. Two translucent, round Plexiglas disks, 0.15 m in diameter, separated by 0.36 m, were centered 0.76 m from the base of the panel. Two identical disks were spaced 0.51 m below but were not used for this research. A galvanized-steel feeder 0.15 m in diameter, was located in the center of the panel, 0.43 m below the operable disks and 0.53 m from the floor.

By reaching with its trunk, the elephant pushed a disk, triggering one to three microswitches located on the reverse side of the apparatus. Correct and incorrect responses were recorded on counters situated inside the box. The three-microswitch arrangement for each disk provided a uniform recording even when only one corner of the disk was pressed. Control and recording equipment was located inside the support structure of the operant panel that served as an enclosure for the experimenter. Floodlights (150 W), mounted on adjustable swivel bases, were adjusted to provide equal

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luminosity for each disk. Sugar cubes were delivered through a Plexiglas tube into the feeder, which was constantly accessible to the elephant.

Procedure

No deprivation was used because subjects readily worked for sugar cubes that were not part of their daily diet. Subjects were tested to criterion for a maximum of 2 hr per day. Side correct was randomized with an intertrial interval of 6 sec. A noncorrection procedure was used.

RESULTS

Table 1 shows the cumulative results for trials to a criterion of 20 successive correct responses. Tuy Hoa made only two errors and took 6 min to reach criterion on a problem not experienced for 8 yr. Both Rosy and Belle had significantly greater trouble and it became apparent that they might be suffering from a visual difficulty. Belle had to be trained for the first several days (647 responses) by hand guidance to the stimulus lights. It took Belle a total of 2863 trials to criterion and Rosy required 1240 trials (see Table 1). Consultants on vision were called in and an apparently significant vascular deficiency was discovered in the retinae of Rosy and Belle. Retinal photographs support these preliminary findings. Comparisons with "normals" are being made to define the degree of retinal change.

Table 1

Cumulated Correct and Error Responses

Subject	*Tuy Hoa*	*Rosy*	*Belle*[a]
Total correct right	18	598	1672
Total correct left	23	198	400
Total correct trials	41	796	2072
Total trials to criterion	43	1240	2863
Total time	6 min	3 hr 25 min	11 hr 50 min

[a]Includes shaped and colored light trials.

After it had been determined that Belle's results would be incomparable with those of the other animals because of the extensive shaping and visual problem, lights of various colors were used in an attempt to see if this subject might show greater sensitivity. Although improvement was indicated when blues and greens were employed, order effects preclude statements of statistical significance.

DISCUSSION

In essence, there are two major sets of results. The first tests employing Tuy Hoa illustrate considerable retention after an 8-yr interval. The statement must remain rather qualitative because of the destruction of Squier's earlier results. It is apparent from current work with a number of other elephants, that no subject acquires the discrimination with only two incorrect trials, and we feel safe in saying that Tuy Hoa remembered. Studies with new animals are progressing so that we can soon make more quantitative statements about retention, albeit with much shorter intersession intervals.

The other two subjects yielded data that is a strong argument for the "fringe benefits" of an active behavioral research program in the zoo. A significant physical anomaly was identified that might otherwise have gone undetected indefinitely. Investigations of the origins of this difficulty will involve a number of researchers with interests ranging from genetics to ophthalmology. Because of physical and budgetary limitations, Belle's trials, which were accomplished with colored lamps, were conducted in a fashion that could yield only vaguely suggestive results about possible color vision. The evidence in the literature on color vision in elephants is also quite fragmentary (Duke-Elder, 1958; Rensch and Altevogt, 1953). Subsequent to the experiment reported here, additional trials using simple colored lamps were conducted that consistently suggested that the elephants responded with fewer errors when green and blue bulbs were used than with white, red, or yellow. Since our crude color data and that reported for colored blocks (Rensch and Altevogt, 1953) do

nothing to equate luminosity nor to provide monochromatic sources, we are working on those refinements.

Because fine-grade testing of parameters like color vision is seldom effected with many varieties of exotic animals, it is not even possible to judge, at this time, the extent of this difficulty. Indeed, it may well be the case that in areas where pachyderms are maintained indoors for large parts of the year with significantly reduced lighting, impaired vascularization and visual difficulties may be the rule rather than the exception. This admittedly conjectural discussion calls attention to the significant lack of knowledge of basic medical parameters with a species quite commonly kept in captivity. As zoos and other animal facilities progress from menageries to effective educational, entertainment, and research facilities, long overdue systematic establishment of standard health parameters is beginning to evolve.

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